BTeV Schedule and Documentation

Michael Lindgren

Director's CD-2 Review of BTeV

September 28-30, 2004

Overview

- Management Tools
- Scheduling Overview
  - Staging
  - Contingency
  - Critical Path
- Subproject schedules
- Installation schedule
- Project Documentation

Management tools

- Utilizing key management systems that are already in place at Fermilab.
- The EVMS for the BTeV Project obtains actual cost data electronically from the FNAL Oracle project accounting system and uses a combination of:
  - Welcom OpenPlan® for scheduling
  - Welcom COBRA® for cost estimating, earned-value planning, earned-value measurement, and variance reporting.
- Will use Welcom WelcomHome ® for statusing
- Document control - use an existing document control system, which was developed in-house to manage the BTeV project.

Scheduling Overview

- All subproject cost estimates and schedules have been implemented in Welcom OpenPlan®. Each L2 manager is responsible for their OP file.
- Project office "linked" the subprojects into a "master project". This allows us to get resource profiles and costs for the whole project.
- OpenPlan calculates the critical paths and detailed floats for each subproject.
- Insufficient number of OpenPlan licenses, so:
  - standard profiles provided in PDF format.
  - Web based browser, a.k.a. OBrowser, for detailed review of schedules

Scheduling Overview(2)

- Uploaded OP master to Cobra in August successfully
- Revised schedule will be uploaded to Cobra and used to create cost accounts/work packages for the baseline project
  - Done by Oct. 1, 2004

Overview of Schedule Changes since CD-1

- Staging of Detector
- Uniform method of calculating schedule contingency
  - Separation of construction and installation phases
  - Total float held at end of project(minimal distributed contingency)
    - This and obligation profile determines needed BA
  - Distributed contingency along critical and near critical path
    - This and cost profile determine performance/reporting baseline
- Funding shifts between subprojects and fiscal years
- Increase scheduled installation time
- No construction activities before April 1, 2005
- With these changes, believe we have a baseline-able schedule – From Lehman CD-1 report:
  - **The committee found the proposed schedule for the construction of the detector is reasonable and appropriate in view of the technical tasks and proposed funding profiles.**

2 Stage Installation

- In Stage 1
  - August through November 2009, install:
    - C0 Interaction Region
    - Pixel detector
    - Gas-radiator RICH system.
    - 1/2 of the electromagnetic calorimeter
    - 5/7 forward tracking stations
    - 2/3 muon stations
    - 4/8 trigger paths
    - ~50% of DAQ capacity
- 7-month run will follow - December 2009 to June 2010.
- In Stage 2
  - July-September 2010, install
    - Remaining ½ of the calorimeter
    - Liquid-radiator RICH system
    - final elements of the tracking and muon system
    - final part of the data acquisition and trigger capacity

"Ready-by" Dates

- Use to define critical path that separates construction activities and installation activities
- "Ready by" dates apply to the construction phase.
- Schedule for each component based on a best estimate of activity durations – gives probable date when each component is complete and ready to install – the "Ready by" date.
- No explicitly included float – there is some from FY boundaries
- Ready by dates done for all components; of a subgroup of components that are to be installed together; or, where appropriate, of a single component.
  - Ex: Pixel detector is installed as a single object -> single "Ready by" date, which is the date the detector is ready to install in C0.

"Need-by" Dates

- "Need by" dates apply to the installation phase.
- Integration and Installation Subproject defines installation schedule relative to the planned Tevatron shutdowns.
- Determines the date on which a detector or a subcomponent is needed for installation – the "Need by" date.

- The difference between the "Ready-by" and "Need-by" dates determines the total float for the subproject

Subproject Schedule Contingencies

Subtask	"Ready by"	"Needed by"	Float (working days)	Staged
Magnet, Toroid (1.1)	Jul. '06	Feb. '07	144	NA
Pixel Detector (1.2)	Aug. '08	Aug. '09	259	No(1)
RICH Vessel (1.3)	Oct. '07	Sep. '08	178	NA
RICH MaPMT	Jun. '08	Oct. '09	215	Yes(1)
RICH Liquid Circulation System	Jul. '09	May '10	197	Yes (2)
50% Crystals Loaded	. '08	Sep. '09	159	Yes(1)
100% Crystals delivered	.'09	Aug. '10	187	Yes(2)
Muon Station 2/3 (1.5)	Sep. '07	Aug. '09	474	Yes(1)
Muon Station 1	Sep. '08	Aug. '10	475	Yes(2)
Muon Gas System	Mar. '07	Aug. '09	608	Yes(1)
Straw Station 1,2,5,6,7 (1.6)	Jul. '08	Aug. '09	286	Yes(1)
Straw Station 3,4	May '08	Jul. '10	540	Yes(2)
Microstrip Tracker (1.7)	Aug. '08	Aug. '09	247	Yes(1,2)
50% of Trigger (1.8)	Oct. '08	Oct. '09	246	Yes(1)
100% of Trigger	Aug. '09	Aug. '10	240	Yes(2)
50% of Data Acquisition (1.9)	Sep. '08	Aug. '09	218	Yes(1)
100% of Data Acquisition	Feb. '09	Jul. '10	338	Yes(2)
C0 IR Quads(2.0)	Jul. '08	Sept. '09	297	No(1)
C0 IR Spools	Oct. '08	Sept. '09	235	No(1)
C0 Assembly Area (3.0)	Mar. '06	Jul. '06	90	NA

Project Critical Path

- Normally defined as last element completed in project
- Less easily defined in this project
  - Separation of construction and installation activities
  - Staged detector completion
- Staged subprojects will show a critical path for both stages
- Defined to be minimum float task relative to "Need-by" date
  - All Schedule contingencies shown are in working days
  - If last element completed is needed late in installation activity it is not necessarily the critical path for the subproject

Stage 1 Project Critical Path

- 50% EMCAL crystals loaded is Stage 1 project critical path
  - 159 days of float
  - Driven by Crystal delivery schedule
- Other schedule critical activities are:
  - 50% DAQ complete – 218 days float
  - C0 IR Spools – 235 days float
  - 50% Trigger – 246 days float
  - Pixel detector – 259 days float

Stage 2 Project Critical Path

- 100% EMCAL crystals
  - 191 days float
- Other schedule critical activities are:
  - 100% Trigger – 240 days float

C0 Outfitting WBS 3.0

- Begin Conceptual Design in FY04
  - Increases bid package schedule contingency by reducing Title 2 engineering design cycle
    - Phase 1 construction scheduled to begin late January '05
    - Need to do design work and make procurement by then
  - Reduces FY05 C0 expense ~$250K
- Critical path is the work needed for beneficial occupancy (Phase 1 construction) -
  - Ready by Mar. 2006
  - Needed by July 2006
  - 90 days of schedule contingency
- **Only schedule concern is delay in starting**
- Tom Lackowski will detail in his talk

C0 Interaction Region WBS 2.0

- Unstaged - Critical activity (pixels, Stage 1 trigger, EMCAL)
- Use modified LHC quadrupoles
  - Fabricate 10 quadrupoles and spool pieces + spares
- Long lead-time procurements
  - Superconducting wire, Corrector magnets, HTS current leads
- Design considerably advanced since CD-1
- Critical path - Spool production – 235 days float
  - 11 months between "Ready by" and "Need by" dates
    - Gained 5 months by defining when needed more carefully
    - Net gain of 4 months in reworking task durations
      - Some shorter, some longer, all based on actual experience
    - Reduced number of spool types – reduced spares count
- Schedule driven by start time for procurements
  - Begin procurement process in Jan. 05, need BA by April 1
- Mike Church has details in his talk

Analysis Magnet, Toroids, Beampipe WBS 1.1

- Unstaged system, which includes:
  - Dipole analysis magnet
  - 2 toroid assemblies
  - beampipe
- Subproject scheduled completions are:
  - 1st Toroid installed Mar. 07 – 95 days float
  - Analysis magnet installed by Feb. 08 – 145 days float
  - Beam pipe installed in Summer 2009 – 251 days float
- Minimal schedule risk here
- Details in Joe Howell's talk

Pixel Detector WBS 1.2

- Unstaged – Critical activity
- Technically challenging system
  - 23 Million Pixels, Bump bonding, Motion control, Large Vacuum system
- External vendors required for
  - Sensors, Pixel readout ASIC's, Bump bonding, HDI's
- Followed by extensive construction at SiDet
- Schedule contingency is 259 days
  - Substantial changes to funding profile
    - Advanced purchase schedule by 1 FY for some items
  - Combined preproduction and production orders for sensors, readout chips, and HDI's
  - Added 3 months to hybridization task
- Details in Simon Kwan's talk

- Staged Detector – Gas first, then liquid
- CD-1 review had no major issues with RICH
- Schedule contingency is 197 days (liquid recirculation)
  - Low schedule risk
- Delay in PMT acquisition to shift funds to electronics
  - 204 and 215 days float in PMT's and MAPMT's
  - Commercial acquisition, judged low risk
- No change in cost
- Details in Marina Artuso's talk

Electromagnetic Calorimeter WBS 1.4

- Staged - Critical Path for the project in both Stage 1 and 2
- Lead Tungstate calorimeter
  - 10k crystals needed
  - Readout using PMT's and QIE ASIC
- CD-1 schedule judged to have excessive schedule risk
  - Delays in CMS acquisition
  - Lengthy production cycle
- Increase schedule contingency:
  - Roll in 50% pre-loaded EMCAL structure in Summer 2009
  - Insert remaining 50% in Summer 2010
- Have always pursued multiple vendor strategy
  - 50% in China and 50% in Russia(two vendors there)

EMCAL Crystals WBS 1.4

- Schedule risk due to competition for crystals with CMS?
  - Default plan assumes
    - Chinese crystals begin production 2007
    - Russian crystals begin at higher rate upon completion of CMS production in 2007
  - Discussion with CMS
    - Minimal impact on final delivery dates for BTeV
    - Might result in higher production rates and a later start
- For staged detector
  - 50% loaded structure ready Summer 2008 - 159 days contingency
  - 2nd 50% ready Sept. 24, 2009 - 191 days contingency
- Russian vendor cost increases to ~$5.7/cc represents largest cost increase in project
- Details in Yuichi Kubota's talk

Muon System WBS 1.5

- Staged Detector
- Design is robust and simple
  - 38k 3/8" SS proportional tube
  - Common FE electronics w/ straws
- Will install stations 2 and 3 (behind toroid) in stage 1
- Base cost changed by $412K from CD-1
  - Added QA tech + test stand
- Schedule contingency > 450 days for all 3 stations
- Scheduled to begin parts production in July '05
  - Delays in parts production and tube delivery, etc. introduce some delay in the "ready by" dates
  - Low overall schedule risk
- Staging limits schedule risk in first installation period
  - Full scale mockup of wheel built and tested – works well
- Will Johns will describe in his talk

Forward Straw Chambers WBS 1.6

- 7 independent systems makes staging straightforward
  - Stage stations that do not require removal of ones installed earlier
  - #1,2,5,6,7 – Still provides excellent tracking in early running
- Current contingency is 218 days for Station 7, increased by:
  - "Need by" dates in two stages
  - Incorrect linking of predecessor in chamber construction start
  - 2 assembly lines -> 3
- Most stations have much greater contingency(>300 days)
- Schedules are robust against anticipated delays
- Need to begin final design work by March 2005 in current schedule
- Staging limits schedule risk in first installation period
- Details in Simon's talk

Forward Silicon Microstrip Detectors WBS 1.7

- Staged detector
- No production schedule issues
- CD-1 review had no cost or schedule issues
- INFN will provide most funding for this subproject
- Current contingency is 186 days
  - Still limited by US funding start date
- Staging limits schedule risk in first installation period
- Details in Simon's talk

Trigger System WBS 1.8

- Staged system - Critical activity
- Sophisticated system consists of:
  - Displaced Vertex trigger
  - Muon trigger
  - Global Level 1
  - Trigger management, switches, etc.
- Substantial technical improvement in Level 1
  - Use commercial switch
  - Replace DSP's with commercial microprocessors
  - Lowers cost and reduces schedule risk
  - Moderate increase in cooling required – reflected in changes to WBS 1.10 and 3.0
- Schedule contingency - 246 days Stage 1, 240 for Stage 2
- Details in Erik Gottschalk's talk

Data Acquisition WBS 1.9

- Staged System
- Composed of:
  - Readout electronics
  - DAQ software
  - Detector control system
  - Databases
  - Control and Data network
- Schedule contingency increased by:
  - Staged installation - 50% in 1st shutdown, remainder in 2nd
  - Advanced funding profile
- Current schedule contingency for stage 1 is 218 days
  - Driven by software development
- Details in Erik Gottschalk's talk

- The CD-1 committee recommended longer installation schedule
  - New staged schedule 17 weeks → 30 weeks
  - 50% of EMCAL crystals installed in assembly hall
  - Staged tracking installation
  - Trigger and DAQ equipment installed in the Counting Room can be installed between two long shutdowns
  - Installation plans based on single shift 5-day/week operation
    - OT + Saturdays provide first line of schedule contingency
    - Go to double shifts if needed
  - Comparison - KTeV's installation task
    - Required 6 months
    - Should have many infrastructure tasks already completed

- At CD-1 review - Early annual shutdown activities
  - Many tasks scheduled for the earliest possible shutdown
    - provided little float
    - most could be scheduled for the next shutdown
- Revised so:
  - "Need By" date is "latest point in the latest shutdown" that component must move into the Collision Hall
- Detailed flow and linkages need careful, methodical time
  - Subproject staging defined summer 2004
- Doubling installation time will greatly increase successful installation probability
  - Now compares favorably to similar experiments

Installation Order WBS 1.10

- Installation order(pre-2009):
  - South (un-instrumented) toroid
  - Vertex magnet
  - North toroid
  - RICH detector tank
- 2009 order;
  - ECAL structure
  - North RICH MAPMT
  - Pixel tank
  - Forward tracking beam pipe
  - Forward tracking stations 1,2,5,6,7
  - South RICH MAPMT
- (quasi) independently
  - Muon stations 2,3
  - Trigger and DAQ

Have installation plans for all subprojects consisting of activity descriptions with time estimates for resources and task durations.

Example:

5k crystals to install in 12 week shutdown. Can install 600/per week in single shift, 2 crews. Could install 7k crystals in 12 week shutdown – 40% contingency

Installation Order WBS 1.10

- 2010 shutdown installation
  - Remaining two straw stations
  - 3 strip stations will be installed to complete the forward tracking.
  - Muon station 1
  - Last three RICH PMT arrays
  - 2nd 50% of crystals loaded into EMCAL structure.
  - 2nd half of Trigger and DAQ will be installed
- Have retained 2-4 weeks contingency at the end of each scheduled shutdown activity through 2010
- Details in Joe Howell's talk

BTeV Management Documents

- CDR for full project
- Preliminary TDR for Detector
- Advanced CDRs for IR and C0 Outfitting
- We have three main documents to describe how the project is managed
  - Project Execution Plan (PEP)
  - Project Management Plan (PMP)
  - Project Management System Description (PMSD)
- And
  - Draft Hazard Assessment
  - Risk Management Plan (RMP)
  - Acquisition Strategy
  - Preliminary Safety Assessment Document (PSAD)

Subproject Documentation

Each SUBPROJECT has:

- **Project Workbook with**
  - WBS dictionary and BoE
  - Requirements
  - Participants, Group Organization
  - Personnel Expertise
  - Production, Test, QA plan
  - Installation, Test Plan
  - Risk Analysis
  - Contingency Analysis
  - Management Plan
  - Cost to WBS Level 4(OB)
  - Total Construction Cost
  - Total Construction Cost by FY
  - Labor FTE by inst/class by FY
  - M&S Cost by FY
  - Large Procurements
  - TDR (Detector)
  - Breakout talks
- **Cost Books**

There is a complete reference set of these all the subproject Workbooks and Cost books available. Each breakout room will have a few copies of the appropriate books

Obrowser (OB) is a tool that lets you Navigate information extracted from OpenPlan without needing a license

Summary

- Schedule strengthened by internal and external reviews
- Schedule is now quite credible:
  - Substantial funding was shifted
    - Between projects
    - Into different Fiscal Years
    - Additional external funding
  - Staging allows efficient usage of FY09 funds
    - Crystals, Trigger, DAQ
  - Correct calculation of end points and additional careful work on the schedule linkages created substantial additional schedule contingency without unrealistic task duration changes
- Critical Path is clearly identified
- Believe have developed a reasonable baseline schedule
  - Demonstrate in following talks and in breakout sessions